for cationic resins in the sodium and potassium form

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INTRODUCTION

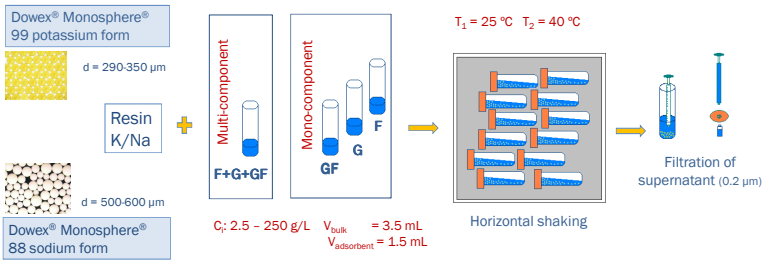
- Separation of glucose from mixtures of fructose and sucrose in molasses is a major challenge in industrial sugar chromatographic separations.
- Sulfonated poly(styrene-*co*-divinylbenzene) (PS-DVB) ion exchange resins are the most frequently used for sugars separation, generally in a cationic form. The cation of the resins used in this study complex with the hydroxyl group of the sugar adsorbed leading to a selective adsorption. Thus, the conformation of the sugar determines its relative affinity for the resin and its distribution coefficient.
- The separation process is usually carried out at high temperatures. However, this implies high energy costs and high levels of hydrolysis.
- The knowledge of the adsorption isotherms of the sugars in a mixture is a very important parameter for the selection of the adsorbent to be used in the chromatographic separation.

OBJECTIVE

- In this study, the adsorption isotherms of glucose (G), fructose (F) and sucrose (S) in mixtures of mono and multi-component at 25 and 40ºC were determined for two resins of PS-DVB in the sodium and potassium forms.

EXPERIMENTAL METHODOLOGY

Static Method



C_i: 2.5 – 250 g/L V_{bulk} = 3.5 mL $V_{adsorbent}$ = 1.5 mL

- Sugars were quantified by High Performance Liquid Chromatography (HPLC)
- Equilibrium loading q (mg_sugar/g_adsorbent)

$$q = \frac{(C_i - C_f)V}{m}$$

C_i – Initial concentration (mg/mL)
C_f – Final concentration in bulk (mg/mL)
V – Volume of sugar solution (mL)
m – dry adsorbent mass (g)

- Adsorption Isotherm Model

$$q = k \cdot C_f$$

k – distribution coefficient (mL/g_{ads})

- Selectivity (α):

$$\alpha = \frac{k_F}{k_G} = \frac{k_G}{k_S} = \frac{k_F}{k_S}$$

- For testing the equality of the distribution coefficient a factorial design was set up as an analysis of covariance at a 5% significance level . SPSS version 17 was used.

RESULTS AND DISCUSSION

Adsorption Isotherms

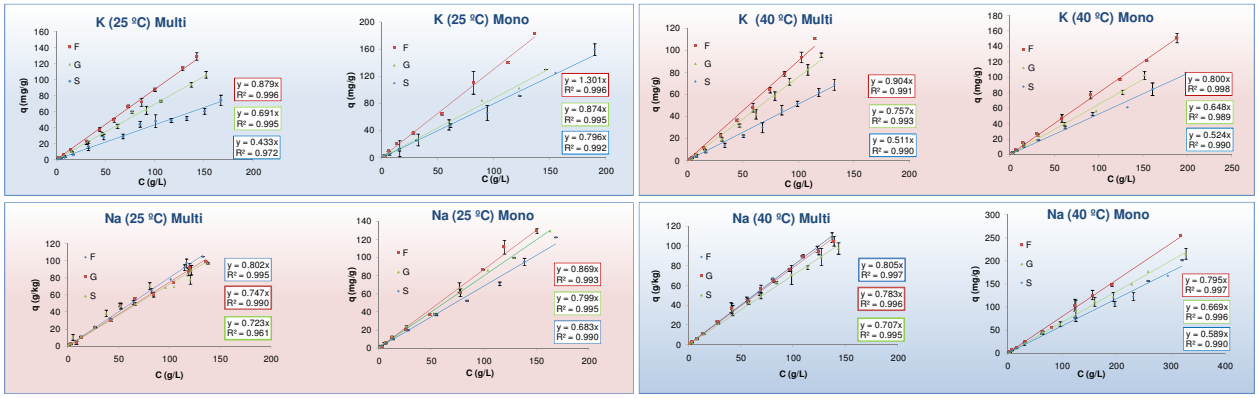
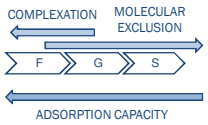


Table 1. Variation of distribution coefficient (k) from F, G, and S with resin (K/Na), component (mono/multi) and temperature (25/40ºC) Increase Equal Decrease

	K resin				Na resin				25ºC		40ºC	
	25ºC	40ºC	Mono	Multi	25ºC	40ºC	Mono	Multi	Mono	Multi	Mono	Multi
	Mono ->Multi	Mono ->Multi	25->40	25->40	Mono ->Multi	Mono ->Multi	25->40	25->40	K->NA	25->40	25->40	25->40
F												
G												
S												

Table 2. Selectivity (α) between sugars:

Resin	K		Na	
T (ºC)	25	40	25	40
F/G	1,28	1,18	1,07	1,03
G/S	1,56	1,49	1,04	1,10
F/S	2,00	1,76	1,11	1,13



Component

- The presence of additional sugars (multi-component) decreased the distribution coefficient, although, for the potassium resin at 40ºC a synergetic effect was found.

Temperature

- In the mono-component mixtures the increase of temperature lead to a decrease of the distribution coefficient, therefore, the capacity of both resins decreased. Nevertheless, the capacity in multi-component mixtures was not significantly affected by the temperature in the sodium resin, and for the potassium resin a small increase in the adsorption was observed.

Selectivity

- The sugars that demonstrated lower selectivity values were F/G since these sugars have the same molecular weight. S/F selectivity showed a higher value as compared to the S/G one because of the complex that is formed between the fructose and the resin.
- For both resins, selectivity decreased with the increase of the temperature. Nevertheless, the selectivity for the potassium resin was higher than the selectivity of the sodium resin.

CONCLUSIONS

- In our case study, the potassium resin appears to be the most suitable adsorbent for an industrial purpose, being the best results achieved for an operational temperature of 25 ºC.

ACKNOWLEDGEMENTS

Agência de Inovação (ADI) – Project BIOLIFE ref. PRIME 03/347.
The authors acknowledge to FCT - Fundação para a Ciência e a Tecnologia for the PhD grant ref. SFRH/BD/32514/2006